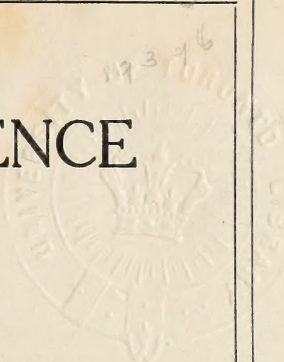


UNIV. OF
TORONTO
LIBRARY



Technical University of Toronto Engineering Society
A

APPLIED SCIENCE



INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Vol. III - New Series

November, '09 to April, '10

PUBLISHED BY
THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

ENGINEERING BUILDING
UNIVERSITY OF TORONTO, CANADA

104850
1519/10

INDEX VOL. III.

European Engineering Laboratories. Robert W. Angus, B.A.Sc.....	I
Spark Discharges. H. S. Fierheller, B.A.Sc.	16
The Engineer—His Character, Training and Personality. Walter J. Francis, C.E.....	19
Petroleum and Coals. Eugene Coste, E.M.	27
A Retrospection. C. M. Canniff, C.E.	34
European Engineering Laboratories. Robert W. Angus, B.A.Sc.....	43
Some Notes on the Design and Construction of an Intercepting Sewer. A. C. D. Blanchard	56
The Engineer as a Business Factor. Eugene Creed	65
Commercial Tests on Transformers. C. L. Gulley, B.A.Sc.....	73
Rotative Dry Vacuum Pumps. Fred W. Moody, B.A.Sc.	80
Modern Methods of Sewage Disposal. T. Aird Murray, M. Can. Soc. C. E.	88
A New Moment Table. C. R. Young, B.A.Sc.	97
Railroad Location. W. G. Swan, B.A.Sc.	99
Boosters and Their Use in Railway Operation. L. S. O'Dell, B.A.Sc.	112
Water Columns for Deep Level Mines. E. J. Laschmyer, M.E. (Tor.)	121
The New Laboratories of the University of Toronto, for Steam, Gas and Hydraulic Work. Robert W. Angus, B.A.Sc.	127
The Annual Dinner	153
The Beginning of Electrochemistry. Saul Dushman, M.A.....	164
Notes on Piping for Steam Power Plants. A. G. Christie, B.A.Sc..	175
Gas Engines. Norman C. Sherman	182
The Engineer and the Finished Work. A. W. Campbell, C.E.	189
The Elastic Arch. Dean Galbraith	195
Coal and the Locomotive. Geo. S. Hodgins	212
Engineering in Canada. Walker J. Francis, C.E.	216
Cost of Sewer, Muskoka. E. A. James, B.A.Sc.	223
Saving Waste in Manufacturing. J. C. Armer, B.A.Sc.	226
The Action of Frost on Hydraulic Cements. Alfred E. Uren, B.A.Sc.	231
Recent Advances in Electricity. C. C. Bothwell	239
Industrial Education. K. A. MacKenzie	242
The Technical: Who's Who. C. M. Canniff	248
A Novel Reduction Gear. J. A. MacMurchy	253
Notes on Architecture. H. F. Ballantyne, B.A.Sc.	264
The Ontario Board of Health Experimental Plant. F. H. Chesnut, B.A.Sc.	281
Reinforced Concrete Columns. Peter Gillespie, B.A.Sc.	291
Building Acoustics. G. R. Anderson, M.A.	306
Practical Hints on Underground Surveying. W. A. O'Flynn	309
Obituary. Charles Goodfellow Milne, William E. Cole, William J. Larkworthy, Wm. E. Elwell, John C. P. Molesworth, L. A. Mc- Lean, Stanislas Gagne, Milton Bates.	315
Address of W. D. Black, Retiring President Engineering Society...	322
Financial Statement	324



FIRST of all, it is essential for the young civil engineer to be well equipped with a good and thorough technical training. Without it, he will soon find his limitations and his efforts will be confined to "rule of thumb" methods. I have had acquaintance with a number of eminent civil engineers who had a meager technical training, but in every case these men possessed some unusual and extraordinary compensating characteristics. The same men, without any question in my mind, would have been pre-eminent with a thorough technical training. It is taking extremely long chances for the young civil engineer or any one else to anticipate his success, using as his gauge the exceptional men I have noted.

Provided, that the young civil engineer's good fortune in youth has denied him those luxuries of wealth which ruin self-reliance and that his college work has been thoroughly and efficiently done; provided, that he has reasonably good health with an ordinary head and applies himself honestly and conscientiously along definite lines instead of scattering his energies, and seeks not the line of least resistance; provided, that he always earns more than his salary, the same being his employer's measure of his qualifications for promotion, and that he does not form the habit of chasing ten dollars a month more salary when he is gaining valuable experience; and provided also, that his early and tender recollections keep his sympathies warm and that he pushes his men by well directed kindness and not by fear:—I will show you within fifteen years' time after his graduation, a man who is courageous in his own convictions, who possesses a tried, admired, and sterling character, and who is a prime mover among the men of his profession.

LINCOLN BUSH,

*Formerly Chief Engineer Delaware, Lackawana
& Western Railway*



ROBERT W. ANGUS, B. A. Sc.
Professor of Mechanical Engineering

Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Old Series Vol. 22

NOVEMBER, 1909

New Series Vol. 3, No. 1

EUROPEAN ENGINEERING LABORATORIES.

ROBERT W. ANGUS, B.A., Sc.

Professor of Mechanical Engineering

During the past summer the writer had the pleasure of visiting Germany, Switzerland, England and Scotland and made it a point to see the engineering laboratories in Brunswick, Hanover, Berlin, Dresden, Munich and Darmstadt in Germany; in Zurich in Switzerland, and in London, Birmingham, Newcastle, Edinburgh and Glasgow in Great Britain.

In Europe, more especially continental Europe, the engineering laboratory has been brought to a great state of perfection so that probably the very best in the world are to be found there. To get even a superficial acquaintance with these one would need to spend a very considerable amount of time and energy, and I very much regret that my time was so limited that it was impossible to study the different institutions as I should have wished. It soon became evident that I must not only omit a number of the Technical Schools altogether, but also that the available time must be devoted to my own special work almost entirely, and it was necessary for me to confine my effort largely to the laboratories in hydraulics and mechanical engineering; i. e., heat engines and boilers and other special mechanical work. This article therefore deals almost exclusively with laboratories used in connection with the above special subjects.

With regard to the schools visited, it should be stated that an especial effort was made to visit the most notable in the different countries. It must not be inferred, however, that only the least important were omitted, because after it had been decided that it was essential to visit certain places, geographical location combined with other circumstances determined those that must be omitted, and some places of excellent reputation had therefore to be left out.

An account of these laboratories will now be given mainly

in the order in which they were visited, and as Germany was the starting point the schools in that country will be described first.

German Technical High Schools.

The Germans are a very thorough and industrious people who believe in doing well whatever they attempt to do. One is not therefore surprised to find that they have been very thorough in the matter of technical education and that they have established engineering schools of the very highest order.

But the development of these schools is not due alone to the characteristics of the nation, but probably quite as much to the great change in the occupation of the people which has occurred in the last few years. In a report on the German Technical High Schools made in 1903 by Dr. Rose to the British Government, it is pointed out that in 1871 the population of Germany was 38,000,000, of whom only about 15,000,000 were in the various industries, the remainder being engaged in agricultural pursuits. In 1900 the population had increased to 58,000,000, of whom about 38,000,000 were engaged in the industries while the number in agricultural pursuits was slightly less than in 1871.

It will be self-evident that the nation which is to have a healthy industrial growth must at the same time properly prepare her people for their opportunities in this regard and must train her men to develop the industries in the best possible way. The importance of engineering schools in this connection is well known and Germany has not been slow to realize this and has established within the last forty years no fewer than ten Technical High Schools for the teaching of engineering and allied sciences. These schools are located at Aachen (Aix) Brunswick, Berlin, Darmstadt, Dresden, Hanover, Karlsruhe, Munich, Stuttgart, and Dantzic, cities pretty well distributed over the Empire, many of them also being located in important industrial districts. The number of these schools is being increased from time to time as occasion demands.

It is to be noted that the above list includes only the Technical High Schools and not the great number of universities and schools of various other kinds which are engaged in a somewhat similar line of work. The term "Technical High School" must not be misunderstood in this connection, as it designates an entirely different class of institution from that to which the name is applied in this country. In Germany the name is applied to the real engineering school, the students in these being of similar standing to regular university students and the courses of instruction being somewhat more advanced than engineering courses here.

The amount of money expended on the establishment of these various schools has been very great and the annual contribution by the State for maintenance is also liberal. It is difficult to get definite information on these points but so far as could be learned the expenditure for buildings and equipment at Berlin

(Charlottenburg) would exceed \$2,500,000, but of course this is far the largest institution of its kind in Germany. At Hanover the expenditure for similar purposes has been about \$500,000, at Brunswick the steam and gas engine laboratory alone cost about \$75,000, while all the buildings at Dresden and Darmstadt, both sets of buildings being new, have cost \$1,300,000 and \$1,500,000 respectively.

The cost of maintenance of these Technical High Schools is also high for various reasons, the most important of which are probably: (1) that the schools are very completely equipped and kept fairly well up-to-date; (2) that there are a great number of instructors and (3) that the fees are comparatively low. The number of students per instructor (including professors, lecturers and assistants) in very few cases exceeds twelve and in many cases is as low as nine. According to the reports to which I have referred, the annual State support to the various Technical Schools varies from about \$178,000 in Dresden, \$98,000 in Stuttgart, \$92,000 in Hanover, to about \$50,000 in Darmstadt, and the total to five of these schools in one year exceeded \$470,000. The balance of the money required to maintain these institutions is received from students' fees and other sources, the above figures giving only the support received from the State.

An opportunity offered itself to learn something relative to this matter about Dresden where it was found that the annual grant for apparatus and supplies for the steam, gas and hydraulic laboratories alone was \$3,000.

It may be interesting to state that for the year 1907-08 the Faculty of Applied Science of the University of Toronto cost the State about \$66,000 (allowance being made for fees received) and the total invested in buildings and equipment in engineering would not exceed \$700,000.

The German people have not been slow to take advantage of the facilities offered along the lines of engineering education for the total number of students in the nine older schools would considerably exceed 16,000. In Berlin alone there were nearly 5,000 students in 1901-02, in Munich in 1905-06 about 2,800, while the present attendance at Darmstadt is nearly 2,000, at Brunswick about 500 and at Hanover 1,500.

These statistics are of some interest in showing how technical education has taken hold in Germany, and as I went from place to place and saw many new buildings and new additions to old ones I was fully impressed with the fact that the people are alive to their opportunities in that line.

That the courses given in these institutions are varied and thorough is at once evident on glancing at any of the "Programmes" issued by them. I might give one illustration, that of the Munich Technical High School, as the calendar for 1906-07 is at hand. The courses there are: (1) Civil engineering, in which there are three divisions—(a) civil engineering; (b) agricultural civil engineering; (c) surveying; (2) Architecture; (3)

Mechanical engineering which is sub-divided into (a) mechanical engineering; (b) electrical engineering; (4) Chemistry; (5) Agriculture. All these courses extend over four years with the exception of Surveying and Agriculture, both of which are three-year courses.

Space will not be taken to quote the list of subjects in each year, but these would indicate more advanced mathematics than is given in this country, and indeed an examination of the entrance requirements for fully-qualified students shows that the latter are much more advanced when they enter than the matriculants here. A fairly large proportion of these entering have a considerable knowledge of both analytical and descriptive geometry, and of the calculus, and are well advanced in the general subjects.

The absence of shops and shopwork is very noticeable in the German Technical High Schools, as these shops are very common both in Great Britain and America, scarcely any institution in the latter two countries in which mechanical engineering is taught being without them. As there is considerable discussion on this question of university shops continually being heard, careful attention was paid to this point, but I was unable to find a single school in Germany with these shops, the opinion apparently being that the proper place to learn shop practice is in the shops of manufacturers, and some experience in this class of work is practically always demanded before graduating, in many cases a year of work in a manufacturing plant being required.

The money which would otherwise be invested in the shops is thus devoted to laboratory equipment.

With this general introduction I shall now proceed to describe some of the schools in detail, and as I went to Hanover first I shall begin with it.

Hanover.

The Technical School at Hanover was founded in 1831 as a higher trades school, was made a Polytechnic School in 1847 and was raised to the grade of a Technical High School in 1879.

An old castle situated in a very beautiful park has been so remodelled as to accommodate this school, but, fine and imposing as this edifice is, it is not so well suited to the needs of engineering as might be desired. However, with the rearrangement of the interior and the addition of a new part to the rear, the building has been made to serve its present purpose very well.

I was informed that there were about 1,500 students, and as there are over thirty-five fully qualified professors and more than this number of assistants, lecturers, etc., the instruction should be fairly thorough. Lectures begin at 8 a.m. and stop at 7 p.m. and the students meet in large class rooms holding over a hundred, the idea of subdividing the classes and repeating the lectures being apparently foreign to Germany. The practice of lecturing to large classes seemed to prevail in all the schools visited.

The laboratories in this institution are not so large as I had hoped, but the apparatus is well arranged and is apparently all used. The mechanical laboratory contains a belt tester and several similar devices, a complete suction gas plant and several gas engines, a 10 h.p. de Laval steam turbine, a triple expansion steam engine, a piston pump, several boilers, and considerable other apparatus. Nearly all of the machines are specially arranged and set up for testing.

The hydraulic apparatus is contained in two buildings, in the one are most of the turbines and pumps, of which there are several types, while the other building contains a long open channel and also a fairly large Francis turbine and a pump.

The open channel is of some interest. It is about 260 feet long, 5 feet wide, 4 feet deep with a suppressed weir at one end. The channel is used for making experiments on current meters, etc., and also for the testing of ships' models, a special car, motor driven, being employed for the purpose. This car is arranged to run at uniform speed and an observer riding on it may obtain all necessary data for a given experiment.

What impressed me most about Hanover was, however, the marvelous collection of models, and I am doubtful if the number of these would be less than 10,000. There is a model of everything one can think of and they seem with characteristic thoroughness to have determined to leave nothing out. There are models of various riveted joints, pin joints, bridges, roofs, turntables of various design, cranes, switches, canals, ships and their parts, steam engines, valve gears, locomotives, mowers, reapers, water wheels, windmills, threshing engines and separators and many other things, as well as many from the Reuleaux collection. Models are also used to show various industrial processes, such as the casting of various ornaments as perfectly as possible, and illustrations showing how silver frogs, snakes and other small animals can be made an exact copy of the real creatures are exhibited. Small mills are at hand to show how wire is drawn, and there are so many things that one is led to wonder who ever can have the time to look at even a few of them.

I felt very strongly that while these things were of interest to the casual visitor, they were of very little help in the way of instruction and represented largely a waste of time and space from the latter point of view. The models are of considerable interest, but are usually too complicated, small and delicate to be useful.

Brunswick.

The next place visited was Brunswick, a city with a population about one-half as great as Hanover.

The Technical High School here is not so large as the one already described although it was established about two years earlier. The school has now complete courses in all engineering branches and it is under state control, receiving an annual grant

of about \$56,000. Lectures begin about the middle of October and close at the end of July with vacations for Christmas, and Easter, making a total of about one and one-half months.

There are here about twenty-three fully qualified professors besides many other professors, and assistants, and there are about 500 students.

The main building is not very large and the mechanical laboratory is in a separate building about a block away from the main one. The latter contains the Rector's office, the collection of models and the electrical, physical and other laboratories.

The electrical laboratory is not large and is in the basement, being used by third and fourth year students. There are several galvanometer rooms and a number of machines are available for testing work.

The collection of models was small compared with that of Hanover, but there would be several hundred illustrating various devices and mechanisms.

The mechanical laboratory, in which I was principally interested, is as already stated, in an entirely separate building a short distance from the main building, and is in charge of Prof. R. Schottler whom I had the pleasure of meeting and who is a man of some note. The building is fairly new though not large, and is bright and well built, and cost with its equipment about \$75,000.

In addition to a small repair shop the laboratory contains a number of valuable machines, such as a 60 h.p. triple expansion horizontal steam engine fitted to work with steam, having 300 deg. superheat. The valve gears are all of different types; the cylinders are jacketed, jet and surface condensers are provided, and in fact every arrangement is made to provide facilities for experimental work. The machine was sold to the school at cost.

Amongst other apparatus the laboratory contains a small suction gas plant and engine, several other types of gas engine and devices for measuring the flow of steam and air.

Special attention has been given to the boiler room which contains a boiler for high pressures and a superheater capable of giving 380 deg. superheat. A special chimney is also available and all kinds of recorders for temperatures, draft, flow of steam, etc., have been installed, making the equipment quite complete in this respect.

Berlin.

In both Hanover and Brunswick the opinion was freely expressed that in order to see the best Technical School one must go to Berlin, and as this institution is well known to us in America my anxiety to get there increased daily, and it was with considerable expectancy that I reached this great German city.

Berlin has a population of about 3,000,000 people and is probably the greatest commercial and manufacturing city in



The Main Building—Berlin.

The Main Building—Berlin Technical High School.



Interior Main Building—Berlin.

Continental Europe. The manufactures include large numbers of locomotives, engines, dynamos, etc., and here one finds enormous shops, such as those of the Allgemeine Electricitäts Gesellschaft, with a working capital of \$25,000,000 and 13,000 employes; the Berlin Maschinenbau Aktien Gesellschaft, a very large concern, having special residences erected for its men; Siemens and Halske; the Borsig works, employing 6,000 men and turning out 450 locomotives yearly in addition to many engines, pumps, etc., and many other very large shops. This city is also the capital of Prussia, is the residence of the Kaiser, and the seat of the Imperial Government.

Here then, in this great city in the midst of so much business and progress one naturally expects to find a first-class engineering school and one does not expect too much, for the Royal Prussian Technical High School is in many respects by far the greatest in Europe, and doubtless also in the whole world. Passing out through the delightful Tiergarten one sees on crossing a small stream the massive "Hauptgebäude" or main building, a magnificent structure nearly 750 feet long and about 290 feet wide with a floor area exceeding 330,000 square feet.

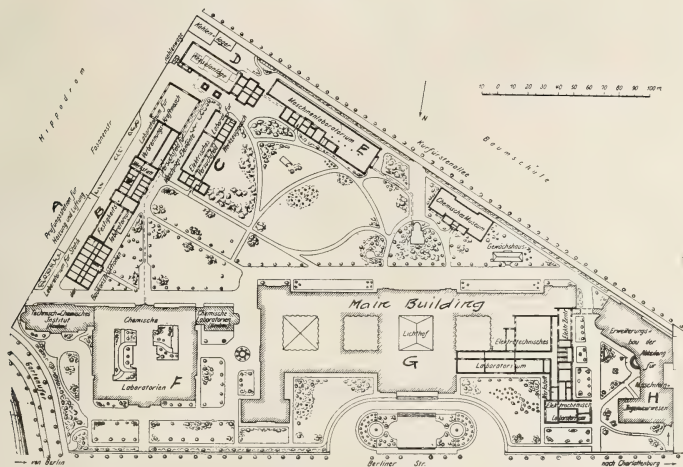
To appreciate fully the grandeur of this building one must visit it, for it is so customary to see engineering schools plain and with very little adornment that one seems to be in a strange atmosphere in this grand place. The building was erected in 1878-84 and is richly decorated with busts and sculptures of such noted men as Gauss, Eytelwein, Schinkel, Redtenbacher and many others, amongst whom it was a pleasure to see Watt and Stephenson. In front of the building are monuments to Alfred Krupp and Werner Siemens. Some illustrations are given of the general appearance of this building.

This Technical High School had its beginning in 1799 as a Royal Building Academy, which was combined in 1879 with a Trade Academy established in 1821. Since 1879 it has borne its present name. On the celebration of its one-hundredth anniversary in October, 1899, the Kaiser granted the school the right to bestow the degree of Doctor of Engineering, a degree first conferred upon Prince Henry of Prussia (*honoris causa*).

There are about fifty-five fully qualified professors besides many assistants, private lecturers, etc., making a total teaching staff of nearly two hundred. There are nearly 5,000 students in attendance, of which number about 80 per cent. are fully qualified. Nearly one-half of the students take the mechanical and electrical course, a fact not surprising in view of the great amount of manufacturing done in Germany.

The Berlin Technical High School, like other Prussian Schools of the same class, is under the control of a Rector and Senate. The Rector is elected annually by the votes of the professors, but his election must be approved by the King of Prussia.

Returning now to the buildings, it will be seen from the plan of the grounds that almost every laboratory has a separate building of its own, the main building being used for the collections of models, lecture rooms, museums, professors' rooms, draughting and other rooms of like nature, some laboratories and the offices of the institution. There are thus ten buildings, viz:—1, The main building, already mentioned; 2, A building for mechanical engineering; 3, A chemical building; 4, A building for experiments on heating and ventilation; 5, A building



Plan of Berlin Technical High School Grounds

Starting from the lower left hand corner and going up the side of the triangle the first building, A, is the laboratory for heating and ventilation research, the next, B, is for strength of materials and gas engine and automobile testing, C, the electrical laboratory, D, the boiler house, E, the engine laboratory, F, the chemical building, G, the main building, H, the building for mechanical engineering.

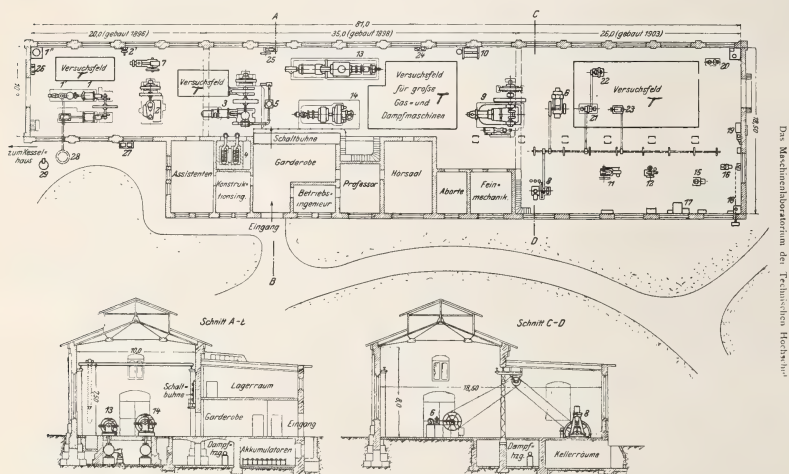
for testing materials and gas engines; 6, An electrical laboratory building; 7, A building for steam engines; 8, A boiler house; 9, A chemical museum; 10, An hydraulic building. These buildings also contain the laboratories for belt-testing for gas and oil engine and automobile testing; and for the testing of the power required to drive machine tools.

In such an institution it is evidently impossible in limited time to look carefully into all the laboratories, so that it was possible only to glance through many of them in order to leave proper time for the machine, gas engine, belt testing and hydraulic laboratories, which will now be described in some detail.

(a) The Engine Laboratory. The building containing this laboratory which was erected in the years 1896, 1898 and 1903, (see figure), is 365 feet long and of width varying from 33 feet

to 60 feet, the clear height of the main portion being 26 feet. It is well lighted throughout by very large side windows as well as by others in the roof and the whole main part is served by a travelling crane of five tons' capacity. Some of the engines are used for light and power, but as there are so many of them in the building no difficulty seems to be experienced in getting any machine desired for experiment.

The laboratory contains a horizontal cross-compound engine of 60 h.p., directly connected to a pump and all parts specially arranged for testing; a 220 h.p. quadruple marine engine complete with condenser; a 150 h.p. triple-expansion engine for superheated steam; a 300 k.w. Brown-Boveri Parsons turbine; a 200 k.w. turbine by the Allgemeine Electricitäts Gesellschaft, Berlin; a 40 h.p. Woolf locomotive type engine



The Engine Laboratory

1 1' Horizontal engine and pump, 2 Quadruple expansion engine 220 H.P. 3 Triple expansion engine 150 H.P., 4 Superheater, 6 Wolf locomotive type engine, 7 Air compressor, 9 Suction gas engine 150 H.P., 13,—300 K. W. Parsons turbine, 15—200 K.W. turbine, other numbers refer to small machines T are test and research floors. The dimensions are in meters.

and boiler; several types of air compressors of good size; a 150 h.p. Deutz suction gas engine; a number of gas and gasoline engines and a Borsig refrigerating machine. In connection with the machines described there are necessary condensers and pumps, gas meters and all conveniences for testing, and nearly every machine drives a dynamo which is used to produce the load for experimental work. Friction brakes are not considered as reliable as electrical loads, so that the former are not used to any extent.

This laboratory also contains a number of dynamometers

of various styles, apparatus for testing nozzles and orifices, and several fairly large testing floors. All pipes are placed under the floor either in trenches or in the basement which extends under part of the laboratory and provides room for some of the condensers and pumps.

This laboratory is well adapted to research work on account of the large size of the machines, and some very valuable work has been done, results of which are published in German periodicals.

It should be stated that the descriptions of the apparatus are not complete, and in such an article as this it is possible merely to mention the more important machines.

The laboratory is under the direction of the well-known Prof. Josse.

(b) The Gas Engine Laboratory. This laboratory, which is in charge of Prof. Riedler, is designed especially for testing gas engines and automobiles, although as previously stated there are a number of gas engines in the engine laboratory just described. The space available for this work is over 170 feet long and varies in width from over 40 feet to about 70 feet, the height being about 25 feet, and all the light being obtained from the sides. The whole of the building is served by a 10-ton travelling crane.

The laboratory contains a 200 h.p. suction gas engine with dynamo constructed by the Vereintigte Maschinenfabrik, Augsburg. This engine, which is four-cycle and double-acting, has the latest type of valve gear, and is well adapted to testing. The gas for this engine is made by suction gas producers, of which there are two of 200 h.p. each, located in a separate building, the gas being led over to the laboratory in pipes.

In addition to the above there is a 40 h.p. Korting engine; a 25 h.p. Korting oil engine; a 20 h.p. Diesel engine; several other engines; special apparatus for doing research work on explosive mixtures; numerous gas meters, etc. The engines are all equipped with dynamos which are used to produce the load.

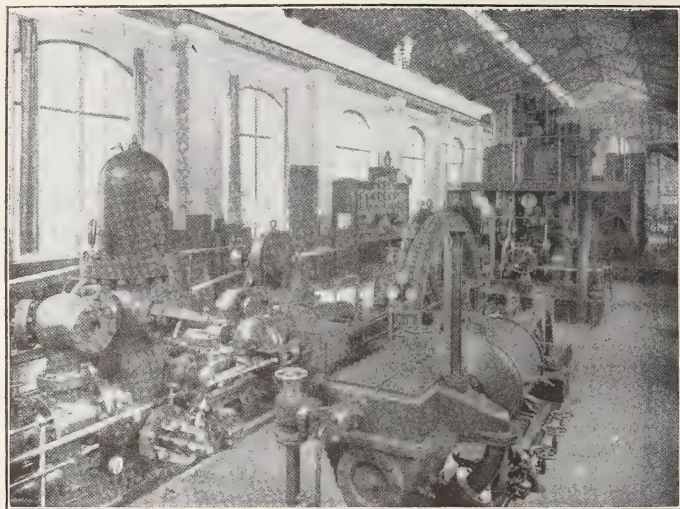
A very interesting feature of this laboratory is the automobile testing plant, designed for testing the horse-power and tractive force of automobiles of all sizes and powers up to 200 h.p. The power of the engine is determined by placing the automobile on a dynamometer driven by the back wheels of the latter, which dynamometer may be adjusted to suit any size of machine. Power is absorbed partly by means of dynamos and partly by Prony brakes, the former being very easily adjusted to give any load desired with great precision. The tractive force is also measured by a special device which cannot be explained here for lack of space.

That this automobile testing plant is in great demand was evidenced by the fact that there were five or six machines waiting to be tested when the laboratory was visited.

There are also testing floors available for other purposes, space being left below these so that access to the lower side of the floor may be easily obtained.

(c) Laboratory for Testing Belts and Machine Elements. This laboratory is about 23 feet wide and 90 feet long, and contains various machines for testing the friction of journals, the holding power of friction clutches, and for similar work connected with the elements of machines. There is also a belt-testing machine capable of testing pulleys 8 feet in diameter, driving a belt as wide as 16 inches. The machine is driven by two 100 h.p. motors which may run at any speed from 200 to 600 r.p.m. Rope pulleys, 6 feet in diameter with four grooves may also be tested on this machine.

The power applied to the belts is measured at the motor and the power delivered, as well as other data relative to the



The Engine Laboratory—Berlin.

working of the belt, obtained by suitable means at the driven end.

On this machine in addition to the work on leather belts and various kinds of ropes, very valuable experiments on the steel driving bands now in use in Germany have been made, and with a machine of this size reliable information may be obtained on full-sized specimens instead of on the small models which must be used in most schools.

(d) Laboratory for Heating and Ventilation. I regret that I have been unable to get any material description of this laboratory. The apparatus is very elaborate and complete and a description is soon to be published. This laboratory is about 500 feet long and 20 feet wide so that it is quite extensive.

(e) Hydraulic Laboratory. This laboratory, which is illustrated here is situated some distance from the other buildings in order to bring it beside a natural stream of water. The stream in question is the Landwehr canal, which is used by barges in the city of Berlin and which joins the river Spree about a mile distant.

Adjacent to the hydraulic laboratory for the Technical High School is the large channel installed by the Government for making tests on ships' models, etc.

In almost all cases hydraulic laboratories situated on natural streams are smaller than those not so situated, because in the latter case a very considerable amount of room is occupied by the large pumping machinery required for the supply of water for turbines of the reaction type, and also because experimental artificial channels must be provided in the buildings to take the place of the natural channel outside.

The above statement is true in general of the hydraulic laboratory of the Technical High School at Berlin which occupies a building over 60 feet long and about 58 feet wide, but also includes a channel outside about 180 feet long. It is in charge of Prof. Ernst Reichel.

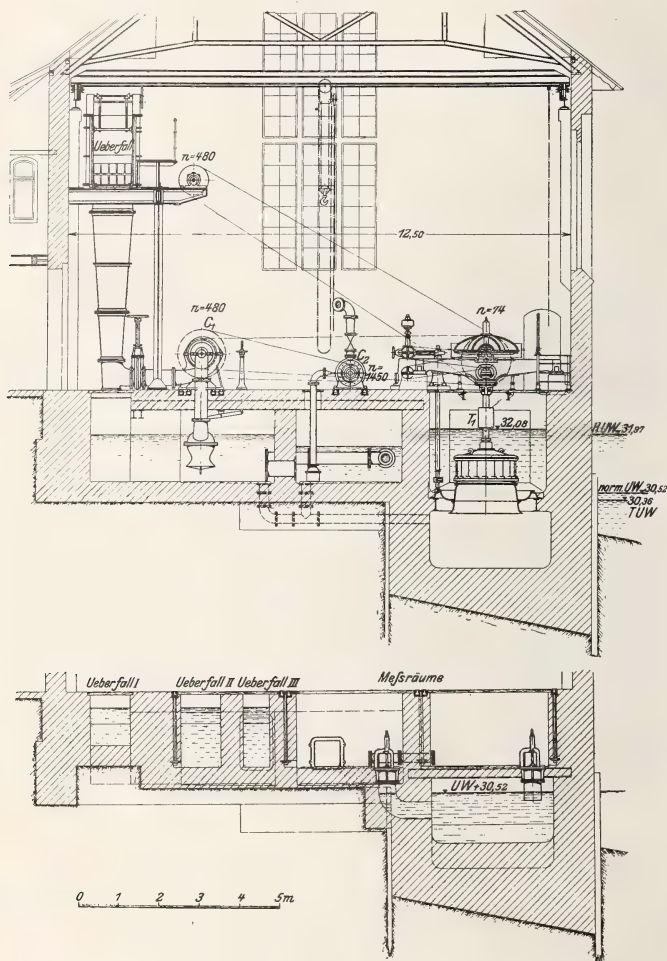
The power obtained from the stream of water is used in driving a turbine with vertical axis made by J. M. Voith, of Heidenheim, for experimental purposes. The available fall is only about 5 feet, but there is a flow of about 85 cubic feet per second, so that the turbine is of fairly large power. It runs at a speed of 74 revolutions per minute and is equipped with a good turbine governor and a brake for measuring the power, but the wheel may also be used for driving the pumps, etc., in the laboratory, if desired. Numerous experiments are made on the wheel and facilities are also provided for the testing of wheels of other makes. The discharge water is measured by a method fairly common in Germany but apparently not used in this country so far as I am aware. On account of the low head available it was deemed inadvisable to use a weir, which would mean the loss of a part of the available head, in this case seriously reducing the latter.

The cross section of the tailrace is rectangular and of uniform section, and a screen of light material impervious to water is made, which is placed in the stream in a vertical position and normal to the direction of flow. This screen is supported on light frictionless rollers, and as it nearly fills the channel the velocity of the screen gives the mean velocity in the cross-section if the screen is properly designed and supported.

This method of measuring water appears to be accurate, and is very convenient, although it cannot be used in any irregular channel nor in a channel of shallow section. In the latter case the screen can scarcely be made to show the average velocity in the stream because it must in all cases be kept some distance above the bottom of the latter, and hence it is not

properly affected by the bottom velocity, the screen thus moving at a faster rate than it should.

On account of the small natural head available a second turbine has been installed to which the water is supplied by a centrifugal pump, and in connection with this there is a long



Hydraulic Laboratory

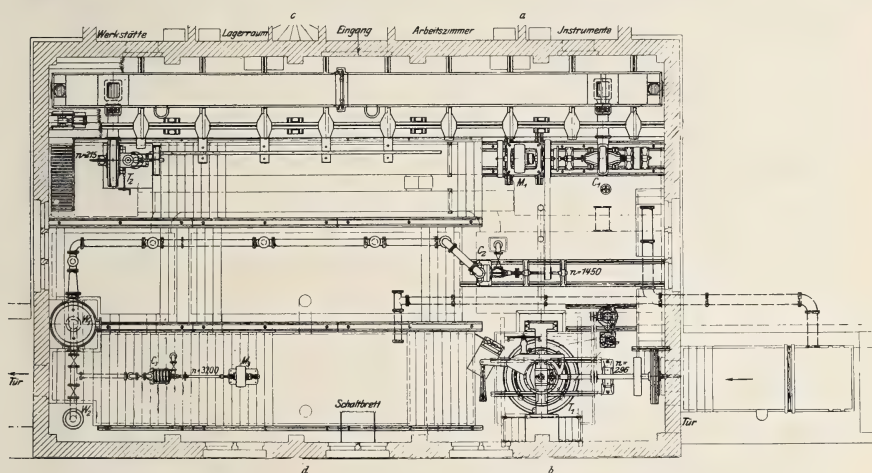
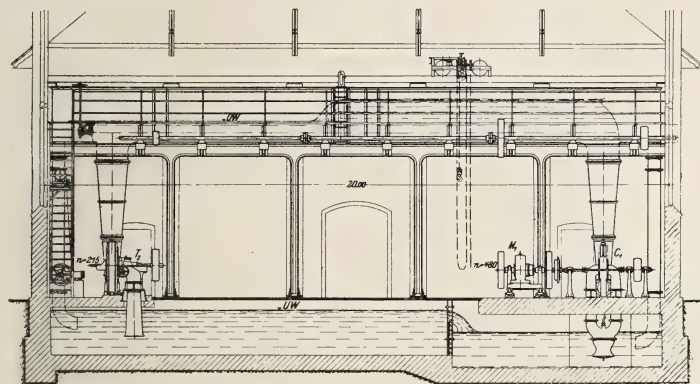
T_1 40-h.p. Voith turbine, C_1 Gehauer pump, M_1 electric motor, T_2 Voith turbine for 20-foot head, C_2 Weise and Monski pump, C_3 and M_3 Jaeger six-stage pump and motor. Measuring channels below the floor are shown. Dimensions are in meters.

steel channel about 3 feet wide, 6 feet high and about 55 feet long, supported near the roof by means of steel columns.

Water is supplied to this channel by a centrifugal pump

built by Gebauer and having a capacity of nearly 9 cubic feet per second against about 24 feet head. The water flows down the channel and after passing over a weir where it is measured, is delivered to a Voith spiral turbine of the full capacity of the pump.

The laboratory further contains a Weise and Monski four-stage pump for 33 feet head and about 0.7 cubic feet per second; a six stage Jaeger pump for 650 feet head; various motors for



Hydraulic Laboratory.

driving the pumps; three fairly large measuring canals under the floor; a large vessel for pressure work, and various other devices for measuring jets and determining the resistance of pipes, etc.

Every facility is offered here for reliable research work and the laboratory is rather crowded. Commercial turbines are also tested here and up to the present time fifteen have been

tried; in such cases the working head, the speed and the discharge are all automatically recorded simultaneously on one instrument.

The apparatus for this laboratory cost about \$23,000, exclusive of the channels, etc., made in concrete under the floor.

This brief description shows that this great school is well worthy of careful study and indicates that the laboratories present exceptional opportunities for research work. Good advantage has been taken of the facilities offered and the institution well deserves the prominent position it now occupies amongst the leading Technical Schools of the world.

In a later issue of Applied Science the writer will give descriptions of some of the other great European laboratories.

SPARK DISCHARGES

H. S. FIERHELLER, B.A. Sc.

This phenomenon was in all probability the first electrical evidence studied by scientists. Franklin in 1750 proved its electrical nature but the early experiments and results do not possess more than historical interest, since reliable apparatus was not available at that time. Improvements in the methods and equipments for research have since then been in order, so that to-day the general characteristics of spark discharge are well understood.

There are many forms of discharges between electrodes but the disruptive discharge occurring when a potential is sufficient to break down a dielectric has most interest to the electrical engineer, and to that only our attention will be directed.

On this subject there is a great mass of literature and while the results obtained by many investigators differ to quite an extent, yet valuable information can be had from a review of some of the methods adopted by earlier scientists.

The phenomenon of spark discharge is influenced materially by existing conditions, and also whether the dielectric is in a gaseous, liquid, or solid state. Dealing with this subject in gaseous media, Carr established the general law, viz., "that with a given potential difference, the field being uniform, the product of the pressure at which discharge occurred and the distance between the electrodes is constant." Here sufficient evidence was found to establish a minimum sparking potential (in air of about 350 volts) in gases and the investigations cover a wide range of spark gaps, and pressures varying from 0.1 to 100 M.M. mercury. The connection between the spark potential and the pressure of a gas for a given spark gap is, as the pressure of a gas diminishes the difference of potential required to produce discharge also diminishes until at a critical pressure the spark

potential reaches a minimum value. Further, if the pressure is reduced below the critical pressure the potential difference rapidly increases. This minimum spark potential has been shown to vary with different gases.

The first spark passes through a gas with far more difficulty than those following, and an appreciable delay invariably occurs in the passing of the initial discharge. This delay is noticed more particularly in the neighborhood of the critical pressure, discharges being frequently obtained after intervals of fifteen or twenty minutes.

After discharge the potential required to maintain a current in a gas is much less than the sparking potential at pressures above the critical pressure, and vice versa. The fundamental laws of electricity no longer hold when a current of electricity is passing through a gas unless extremely small *E.M.F.*'s are used. The most noticeable feature of the discharge is that an increase in the distance between the electrodes increases the current for a constant potential difference. Nor does the conductivity follow Ohm's law but for small *E.M.F.*'s since an increase in *E.M.F.* does not produce a proportional increase in the current, the current increasing more slowly with the *E.M.F.* until it finally reaches a maximum or saturated value. The conductivity has been shown to vary directly as the square of the voltage, but prevailing conditions, such as the introduction of Roentgen rays, pressure, etc., are liable to have such an influence that this property may be increased or entirely removed.

If now, we consider very small sparking distances, there is at once a variety of opinions. Some investigators find that for small spark gaps such as from one to one hundred wave-lengths of sodium light, no evidence of a minimum sparking potential exists. Then on the other hand, Almy has shown that, in his work at such minute distances, the potentials previously recorded do not produce disruptive discharge but rather cause the electrodes to be brought into contact, and further proceeds to verify Carr's conclusion in reference to the existence of a minimum sparking potential.

The discharge in liquids is indeed very similar to that in gases and has been investigated chiefly by the larger manufacturing concerns, and obviously much interesting information has not been published. In most dielectrics the spark appears very bright, in oil it is of a greenish white color, while in alcohol it is red.

The character and application of the *E.M.F.* producing discharges also has its effects. While the data obtained by electric machines may be of no practical value to the electrical engineer, to the physicist the use of an alternating *E.M.F.* has its objections. Where alternating current transformers are used to step up the voltage, higher harmonics are invariably evident. The amplitude of the harmonics is increased by the effect of

capacity which is in turn dependent upon that uncertain element, "time lag," in passing of discharges. Since the voltmeter registers the "square root of mean square" value, and even with the assistance of an oscillograph it is difficult to obtain the peak or break down voltage, unless sine wave forms are employed. Direct current admits of most accurate measurements of sparking potentials as well as producing a steady strain in the dielectric. Sufficient time should be allowed to elapse after a discharge to allow the dielectric to resume its normal state. Liquids, contrary to gases, usually require a higher voltage to produce a second discharge following closely after the first spark, and it is also a matter of common knowledge that oils have poorer insulating qualities for low than for high frequencies. Further, the more rapidly the potential is changed to produce discharge the less will be the potential required to spark across any given distance. The application of a definite potential suddenly will cause a spark to pass farther than if the potential were gradually built up. The sudden rises or surges in *E.M.F.* are frequently responsible in damaging electrical apparatus.

In the study of spark discharges we have seen that it is better to use constant *E.M.F.'s* which produce a steady strain in the dielectric due to the magnetic field. The effect of the field is more pronounced in gaseous media than in liquids and especially in gases at low pressure. The field distribution is greatest near the electrodes but it should tend to distribute the stresses as uniformly as possible to avoid partial break downs. The intensity may be increased by reducing the spark gap and shaping the electrodes.

The effect of moisture in a dielectric is no doubt to facilitate the passing of disruptive discharges. The great majority of failures occurring in high tension apparatus and even in all classes of electrical machinery is invariably chargeable to the existence of moisture in the insulation and in fact all modern manufacturing establishments are equipped with drying and vacuum ovens, etc., for the elimination of all moisture.

Similarly we might mention the effect of temperature. The allowable working temperatures of transformer oils seldom exceed 80° C., although the disruptive strength of oils would appear to be little affected unless some change in the state of the dielectric were brought about. The temperature effects are more pronounced in liquid than in gaseous media, since in the latter the heat is more readily dissipated.

Finally, let us consider briefly the electrodes and their resulting effects. There is little or no objection to the use of parallel plate electrodes where the spark gaps are relatively large, since uniform fields and accurate distances are readily obtained. For small distances, however, this plan is not satisfactory. If discharge occurs between a point and a plane, it will be found that when the point is positively electrified the potential difference will be greater than if the point is negatively electrified and for

comparative tests it would be necessary to maintain the point at one electrification. A similar effect occurs if the electrodes are of different sizes unless the discharge is maintained.

Again, the electric intensity upon small spheres is greater than on large ones and discharges will pass more readily. Hence it would appear the most satisfactory electrodes are medium spheres, necessarily hard and highly polished, to avoid easy disfigurement. In wireless telegraphy also has the subject of electrodes been considered. Here it has been observed that where a point and a disk are used the discharge is brighter than with two points. With a point and a sphere the visible properties become reduced, whereas with disks or flat surfaces there is usually a convective discharge around periphery and discharge shifts from one position to another. So that in practice to obtain the best results it is clear the terminals must offer no sharp edges or points, therefore spheres are the usual form.

The effect of material composing the electrodes seems to have no appreciable effect upon sparking potentials unless the gaps are small enough to cause the passage of minute particles of the metal.

ADDRESS—THE ENGINEER; HIS CHARACTER, TRAINING AND PERSONALITY.

WALTER FRANCIS, C.E.

Mr. President and Gentlemen—Fellow Students:

In order that we may get together let me tell you a little story I heard a short time ago regarding a newly married couple who were staying at a large hotel. The gaze of the curious annoyed them very much and in the dining-room the groom called a waiter to him, saying: "Here, fellow, is a dollar. The stupid staring of all those people is very annoying to myself and wife. We don't want everyone to know we are a bridal party. Just see if you can't get it stopped." The next day the groom again confided to the waiter that they were attracting more attention than ever. The waiter became very serious, expecting to be chided for not having earned that dollar, and he hastened to explain: "Well, boss, I doan know how dat is. I'se been 'splainin' to 'em dat you ain't married at all."

I might have started with a long face and said, "Let us smile." But we are not at the King Edward and it is the clerical sound of the expression that appeals strongly to me just now for I fear before I resume my seat that I shall have done those things I ought not to have done and left undone those things which I ought to have done. In any event I shall do my best.

On an occasion like the present, one is very apt to become reminiscent and I shall ask your indulgence for a moment while

I digress sufficiently to give you a comprehensive idea of what was here in the School of Practical Science in the late eighties in order that you may have a glimpse of the tremendous achievements of that man whom we all respect so highly, that man who stands out so prominently in scientific education, that man whose name will be emblazoned in the pages of the history of engineering education in Canada and indeed in America—John Galbraith. And when I shall refer to the three great features of an engineer's life—character, training and personality—do not forget that you have a model before you constantly while you are in this institution—a man whom we all revere—a man accessible on all occasions to the true student—a man whom it is a privilege to call a friend—our worthy Dean.

It is just twenty years this autumn since the speaker came to the School as a special student in architecture. In those days the wing of the old, red brick building was the "school." The front door faced the campus. There was no regular architectural course. At that time Robert A. Ross, the well known electrical engineer, who was the first regular student in mechanical engineering, took his lectures all by himself from the Principal in his private room. Then, as I presume now, the echo "Five o'clock, gentlemen," resounded through the halls in due time. Dr. Ellis and the Principal were the only two full professors and it was not hard to count the staff. The regular Indian file from lecture room to lecture room is still vividly before my mind. Every student—many of them well up in years—bore that strained expression which read plainly that he had undertaken tremendous responsibilities. Bald heads and full whiskers were not uncommon in the classes. In the comparatively short space of twenty years the old timer returns. The number of buildings, the large staff, the mechanical equipment, the hosts of students bewilder him and he feels lost. Building after building, passage after passage, door after door confronts him until he realizes that it is no wonder that it takes some fellows many years to get out of the place.

Fortunately the day is past when the public thinks of the engineer as a sort of glorified plumber. Engineering is rapidly taking its proper place in the front rank of the professions. The engineer of to-day has to be a broadminded man, skilled in the art of construction and able to meet men. The problems confronting him in adapting the great forces of nature to the use and convenience of man are the greatest in the world to-day. The great financial schemes for the most part depend directly on engineering and the engineer. Wipe out the railroads, the shipping, the ports, the mining and manufacturing appliances, electrical and mechanical devices and you restore a condition in which would revel the American Indian and the Eskimo. The clergyman deals in the future. The lawyer is expected to do the best he can for his client. The doctor buries his mistakes. The engineer erects monuments to his ability or lack of it. The

structures he builds hold in safety the lives of thousands, and provide for the whole world those things which may be said to constitute its civilization.

It is a safe hypothesis that the engineer of to-day has received a technical training. There are some, of course, who cannot get it. In the past the privilege did not exist. Many of the greatest engineers of the world never saw the inside of a university. If they had done so no one can say what their accomplishments might have been. But the feature I wish to mention particularly is this—the trained man has an equipment which enables him to solve problems and overcome difficulties which none but the highest genius can otherwise surmount. The trained man with a proper appreciation of things is able to attack his problem and reach a solution in a fraction of the time occupied by one not so fortunately equipped. But do not mistake me. Engineers, like poets, are born, not made. No amount of technical education will enable one without the natural inclination to become an engineer worthy of the name. It is more than likely that the great majority of those whom I address have the true natural instincts of the engineer. My sincere wish is that you may all be eminently successful. But in a body so large there may be some a little out of place. It is remarkable to think of the small happenings, the trifling occurrences that influence us in life at times. Why some of you are not in arts or medicine you know best yourselves. If your choice has not been a happy one I trust you may be able to realize it before it is too late.

I see that the bulletin board has confined me to a subject—the influence of character, training and personality in the work of the engineer—and I must bow in submission. The effect of character, training and personality cannot be lightly passed over in connection with the work of an engineer. I trust you have all read Mr. Stern's most excellent address entitled "Advice to the Young Engineer," published some months ago in *APPLIED SCIENCE*. If you have not done so, procure the copy at once, and read carefully also the discussions that Mr. Stern's remarks evoked from leading engineers. Too much cannot be said on the subject. Let me take the main points in order—first, character; second, training; third, personality.

The first and most important element in the character of every man is honesty. "Great is truth and mighty above all things." If I were asked to describe in a word the science of engineering, I would say "truth." The words "the truth shall make you free," certainly apply to the engineer. When you know the truth of the materials you handle, the truth of the principles you apply in handling them, and you are true to yourself, then you have reached the proper position for an engineer. Don't deceive yourself. Don't try to make yourself believe something about which you have any doubts. Be clear. The engineer must be true to others as well as to himself. He deals with truth as far as it may be available. Keep your honor bright. The

acknowledgement of an error or of some shortcoming does not affect your integrity. Above all things be honorable. The student who tries to make himself believe he understands when he does not is his own worst enemy.

In student life, freed from home restraint, there is possibly the tendency on the part of some toward dissipation. Against this let me warn you in the strongest terms. The student in his vigorous young manhood should be most careful in this regard and cultivate the proper spirit of manly self-control. His associations and associates should be of the highest character. He should form alliances with those societies which seek to benefit mankind. His friendships should be true and lasting and he should cultivate particularly the acquaintance of good men and good women. He should practise moderation in everything and not be given to any excess. With a character so developed, trained honestly and combined with a pleasing personality the young man is thoroughly equipped for life's battle.

The engineer receives his training in two schools — the university and the school of experience. Let us refer to the university life as education and apply to it Lord Kelvin's definition: "The first object of an education is to enable men to live; the second is to enable other men to live." Many persons in addressing you on these subjects would deal with the importance of trigonometry and higher mathematics. I would go farther back still and say the subjects of first importance are the three r's—readin', 'ritin' and 'rithmetic. These are the subjects the engineer uses most and consequently abuses most. Not one in a hundred can read well. Accountants can write the addend of many columns of figures before an engineer gets down the first column. The handwriting of many engineers would be put to shame by the characterless efforts in a schoolboy's copy-book. Too much importance cannot be placed on the necessity of being able to write a clear, legible hand denoting character.

As to the age of admission, I would advise nobody—I speak as a general rule, and of course there are exceptions—I would advise nobody to enter an engineering course before the age of 20 or 21. Get a general education, go and drive a grocery wagon, learn something of the rough corners of the world, get a little appreciation of things, and then—then you are in a better position to absorb the wonderful truths imparted so thoroughly within these walls and to appreciate their meaning and importance. The immature mind of the boy is quite unable to grasp the full importance of the lessons taught. Engineering lessons must not be done like school lessons. Forget all about your examinations. Imbibe the principles and the examinations will take care of themselves. Everything placed before you in the course is done by competent academicians after mature consideration. You yourselves are not yet in a position to judge of it. But whatever you do, absorb the principles. Let me

hesitate for a moment to say that nothing short of loss of sensibility will ever knock $\frac{p}{y} = \frac{M}{I}$ out of my head, and I trust his

assistants are following in the footsteps of their Master-mind who so thoroughly impregnated our being with "first principles."

As I said, everything is important. But somebody will doubtless expect to hear some subject mentioned specifically. Learn all about drawing. More graduates have obtained a start in life through their draftsmanship than in any other way. Give particular attention, too, to the adjustment of instruments and the elimination of errors in them.

Be attentive to your engineering society. Attend its meetings and take part in its discussions. Cultivate public speaking. Here let me throw a bouquet. Many of you were at that memorable gathering in Convocation Hall last January when the Canadian Society of Civil Engineers were the guests of our Society. You will recall the speeches delivered by the undergraduates on that occasion. It is my good fortune to be personally acquainted with the graduates of many institutions all over the world, and you would blush with pride were I to repeat to you the complimentary things said of your speakers at that gathering. In the Engineering Society you have opportunities you cannot get elsewhere.

It has been said that a man goes to the university to learn how to learn. One of the great sources of learning is reading, so I say, learn how to read. Read regularly the recognized engineering periodicals. Attain all the breadth and culture within your reach. Get out of the little sphere in which you have been reared. Remember that there are other peoples and nations, other viewpoints and systems. Don't be narrow-minded.

And don't be discouraged if you can't stand high in your class. The slow student is not necessarily a poor student. The students referred to frequently as the "best" often do not make the best engineers. Remember what I said a few minutes ago—engineers are born, not made. For the encouragement of those who may feel a little discouragement now and again because they seem unable to keep the pace, let me repeat—be sure of your general principles, build on the solid foundation of good character added to a properly developed personality, and success is yours. The mathematician, for example, may be a leader in classes, but he will find the cold, hard world far from being mathematical. I know of expert mathematicians who are of less real service than a good office boy in actual life.

Now when you graduate, be careful. You have done well. You have made a good start. Probably your hat feels very tight—but nobody else thinks so. You are only commencing to begin. The school of experience is not easy to matriculate into. The course for many is a hard one. None of us may say what the hand of Destiny has in store for us. We enter life. The

race is harder for some than for others. The prizes are many but the handicaps are likewise many. Some do not start. Others get away at the first sound. A few fall by the way. As we go on the journey we gather information to enable us to run more easily and possibly more rapidly. The adverse winds are not felt or encountered by all. For the great majority there are prizes.

In the school of experience you learn how to appreciate the general principles and how to make proper assumptions in order to use them. You learn that at times a carpenter's line and square have their place and at times they are more expeditious to use than a transit. You learn—if you are wise—how to do everything that concerns your chosen line. From every person with whom you come in contact you learn. The Italian with his rock pick can show you how to strike a blow that will loosen twice as much rock as you can. Every mechanic can show you details that you never dreamed of. Every hardware clerk can name a score of standard engineering articles that you do not even know the commercial name of. From the foreman you will learn how to handle men. From the contractor you will see how to handle work. Everywhere you go and turn you can acquire information. Don't consider anything too menial. The engineer who is able to rise to the emergency is the man who commands respect and who will be followed by all. Know how to tie ropes, drive rivets, make the injector work, fire a boiler, tap nuts, wipe joints, handle a trowel, handle blasting materials, and the thousand and one things that have to be done on works. And just here let me give a word of warning to the young man who thinks it of more importance on works to be ornamental than useful. Hesitate for a moment—probably you are the only one who ever even dreamt of the ornamental aspect, notwithstanding your high collar and fine clothes.

Be careful to acquire a complete experience in the details of office work. Learn to use a typewriter. Find out all the office boy does and be sure you can do those things yourself. You would be surprised to learn how few engineers can dictate a letter, typewrite it, copy it and mail it in due form. But these things have to be done personally at times, so learn how.

Learn to make proper records, notes and sketches. Remember, you may not be on hand to explain something later.

Get a year's experience in a bridge company's office, for there you will learn what is really only high-class clerical work—bridge drawings for shop work. Nothing else gives so good an insight into the art of commercial draftsmanship.

Learn how to take photographs. You can pay for the developing and so forth, but the taking is the important feature. Only the engineer knows what to take and when to take it.

Do your specializing after you leave school—you may begin to think about preparing to specialize when you enter the school of experience.

Above all, learn to accomplish things. In these days they

want the man who can do things. Don't be content with ordering. Get busy. Accomplish a result. Carry the message to Garcia.

Cultivate the habit of being ready to work. Keep on your person all the little odds and ends you need from moment to moment.

Be sure you're right, then go ahead.

Just to relieve the monotony let me tell you another story. It tells you what monotony really is at times. If you wish another excuse for my telling it I may say that it was told at a banquet in New York where probably the largest number of English-speaking engineers that ever assembled were gathered around the festive board at Delmonico's. I well remember one of the leading speakers describe a lawyer addressing the jury in defence of his client who was on trial for being too much married. Striking an attitude, the legal man said: "Gentlemen of the jury, when a man has many wives we call it polygamy. If he has two wives the law terms it bigamy. But if he has only one wife that's monotony."

Now as to personality—who may define it? I cannot. There are many things we know about it, but who can say exactly all the reasons why some attract us while other persons repel?

Probably personality has as much to do with obtaining employment as any other single feature. The Dean stated in one of his addresses that an engineer should be 100 per cent. engineer and 100 per cent. man. The statement is mathematically correct. Be manly. Be congenial. Cultivate proper friendships. The friendships which many engineers prize most are those made when they began life and earned their position through integrity, ability and manliness. Don't be a worrier—nobody cares to have him around.

The personality is very clearly shown in letters of application for employment, so be careful how you write them. It is still more clearly shown in applying personally for work.

Don't be eccentric, for none but a genius can afford to be so.

Co-operate with those with whom you are associated. Don't antagonize.

Before I resume my chair let me pass on a few general words of advice. The question of success is one of life's problems and as such can be discussed *ad infinitum*. It cannot be denied that there is a tide in the affairs of man which if taken at the flood leads on to fortune. I trust you may appreciate opportunity when she knocks at your door.

Cultivate a horror of fossilizing. When you find you have a snap it's time for you to make a move. Any fellow can get along when things go straight but it takes a good man to make them go under difficult conditions.

In handling your work, if you wish to make speed lend a hand with the menial work. A survey can frequently be done quickest with the leading man driving stakes. More time is lost

on any work doing the trifling things than the apparently more important ones.

While you're working forget the clock. If any of the members of your body assert themselves there's something wrong. And there's something wrong when you are worrying about what time it is. When your employment is congenial and everything is going well you forget there is such a thing as time. While speaking of this let me strongly urge all young men to be careful about punctuality. Keep your appointments to the minute and expect everyone else to do the same. The young men on construction works should be there from whistle to whistle.

Again I say, be broadminded and liberal in your views. In late life you will be placed in somewhat judicial positions. Remember, there are two sides to every question.

Dr. J. A. L. Waddell in one of his addresses refers to an engineer thus: "He must be intensely practical yet perfectly technical; minutely accurate yet properly approximate; firm in his beliefs, yet open to conviction, knowing where firmness stops and stubbornness begins; courteous and helpful to his contractors, yet never conniving with them to the slightest degree; dignified yet affable; and in short, a thorough gentleman, yet never ashamed to do any work, however apparently menial, provided that it belongs properly to the engineering profession." Let us look at that quotation again.

In conclusion let me repeat—be honest, be studious, be a man. Ally yourselves with those organizations which make for the benefit of mankind, and keep out of politics.

The keynote of the whole is, be natural.

PETROLEUMS AND COALS COMPARED IN THEIR NATURE, MODE OF OCCURRENCE AND ORIGIN.*

EUGENE COSTE, E.M.

There is found in nature a great variety of compounds of carbon, not only in the sedimentary strata of all ages, but also in crystalline rocks, in igneous and volcanic rocks, in seams and veins through all these, and even in meteorites.

All these carbon-compounds have been assigned by many geologists to the one and the same origin, namely:—an organic origin, from the decomposition or distillation of either animal or vegetable organic matter entombed in the strata, and they have all been grouped and classed in the one and the same series of compounds of carbon.

This organic origin cannot of course hold good for the natural carbon-compounds found in crystalline rocks, in igneous and volcanic rocks, in volcanic gaseous emanations, in metallic seams and veins where they are intimately associated with such minerals as quicksilver for instance, and also when they are found in meteorites. It has, therefore, always seemed to me that this idea of only one natural series of compounds of carbon with an organic origin, is so clearly at variance with so many well known geological facts and physical laws that I cannot cease to wonder how it is possible for such a huge error to have taken the firm root it has in the science of geology. In two papers which I read before the Canadian Mining Institute, one nine years ago ⁽¹⁾ and one six years ago ⁽²⁾, and in another paper which I read in 1904 before the American Institute of Mining Engineers ⁽³⁾, and before the Franklin Institute ⁽⁴⁾, I entered my strong protest against this fallacy. I pointed out in these papers the solfataric volcanic origin of the natural hydrocarbons or petroleums. Other geologists have also long ago given proofs of the inorganic origin of petroleums, especially Berthelot, Mendeléeff, Eli de Beaumont, De Lapparent, and a number of other writers mostly French and Russian.

But it evidently takes a long time to establish definitely even simple and palpable truths in science, as may be judged from some of the recent literature on the subject ⁽⁵⁾ in which the derivation of the natural hydrocarbons from organic matter is either again admitted without discussion or again sought to be proved. It appears, therefore, necessary that some of the facts in the case be once more presented, and I have adopted in this paper the comparative form between coals and petroleums, in the hope that it will bring out more forcibly and more clearly

*Address before Mining Section Engineering Society, October, 1909.

1. Journ. Can. Min. Inst., Vol. III, 1900, pp. 68—89

2. Journ. Can. Min. Inst., Vol. VI, 1903, pp. 73—128

3. Trans. Am. Inst. Min. Eng., Vol. XXXV, pp. 288—297.

4. Journ. Franklin Institute, Philadelphia, 1904.

5. The Data of Geochemistry, Bulletin No. 330, U. S. Geol. Survey, pp. 619—641.

See also U. S. Geol. Surv. Bull. No. 250, 265, 282, 285, 300, 309, 317, 318, and others.

how entirely and absolutely different some of the natural carbon-compounds are to others in their nature, their mode of occurrence and their origin; and in the further hope that it will demonstrate that there are really two series of natural compounds of carbon, namely the Organic or the Coal Series, or Coals, and the Volcanic, or Petroleum Series or Petroleums.

Nature.

Coal Series.—The coal series includes the natural carbon-compounds grading into one another from vegetation into peat, lignite, soft coal, semi-anthracite and anthracite.

One hydrocarbon, namely marsh gas or methane, is known to form, during the natural decomposition of vegetation, into coals; this is the only hydrocarbon thus formed. Many other gaseous or liquid hydrocarbons may be produced by the destructive distillation of carbonaceous matter or of coals, but these have nothing to do with the carbon-compounds formed in nature by the normal geological processes, as the destructive distillation of the sedimentary strata and of its carbonizing vegetation is not a normal geological process and never took place. This is conclusively proved by all the undistilled ignite and coal beds of the sedimentary strata all over the world and by the want of coke beds in these strata.

Petroleum Series.—The petroleum series includes all the natural hydrocarbons with the exception of the marsh gas above mentioned. These petroleums grade from natural gas into fluid crude oil or petroleum proper, into semi-fluid maltha and into viscous or solid bitumen or asphalt in their many varieties, of which such minerals as grahamite, gilsonite, elaterite, napalite, ozokerite, albertite, anthraxolite, are only a few. As the end products of the petroleum series there are good reasons, as we will see, to include both graphite and diamond, whose deposits prove that they also have had a similar inorganic origin.

A good definition of the nature of petroleum is the one of Mabery ⁽⁶⁾ as follows: "petroleum, from whatever source, is one and the same substance, capable of a simple definition:—a mixture in variable proportion of a few series of hydrocarbons, the product of any particular field differing from that of any other field only in the proportion of these series and the members of the series."

Mode of Occurrence.

Coals.—With regard to the mode of occurrence of the members of the coal series it is only necessary for the purpose of this paper to note that they are always found in regular beds of the sedimentary strata spreading uniformly far and wide, often over hundreds and even thousands of square miles.

There is only one point which I think pertinent to make here with regard to the mode of occurrence of the coals, and that

6. Journ. Am. Ch. Soc., 1906, XXVIII p. 417.

is that no coal beds are found below the Carboniferous period. A small amount of coal or carbonaceous matter is, however, found in some of the Devonian shales, but this never passes into pure coal beds and fewer and fewer of these carbonaceous shales are found in the Silurian and Cambrian. The science of geology has always interpreted and explained this fact—that so little coal is found below the Carboniferous—on the understanding that before Carboniferous time the conditions for the existence of considerable growth of vegetable matter were unfavorable and it is a geological heresy to speak of or to believe in coal beds existing in formations lower than the Carboniferous; geology teaches us that they cannot and do not exist there. How is it then that there are so many large deposits of petroleum below the Carboniferous? It could not be because there was so little vegetable or other organic matter entombed in these early strata, unless their origin is not in any way organic.

Petroleums.—If the mode of occurrence of coals is well understood, the mode of occurrence of petroleum certainly is not, and hence the great misunderstanding by so many concerning the origin of the later. Some geologists have passed such, to them, unwelcome cases over with the remark that the petroleum in the igneous or volcanic rocks were no doubt due to the distillation of the bituminous shales cut through by the intrusions; but how can a hot rock distill or drive away a vapor into itself? In one of my previous papers (7) on this subject before this Institute I cited a good many instances of petroleum in volcanic emanations or in igneous or volcanic rocks, and for full particulars of these reference may be made to this publication, but I will recapitulate here what these instances prove beyond all doubt:

1st. The occurrence of graphite in igneous gneisses, granites, gabbros, pegmatite dykes and in a quartz-porphry dyke.

2nd. The occurrences of hydrocarbons in the gaseous inclusions of the crystals of igneous rocks.

3rd. The occurrence of petroleum (liquid, semi-liquid and solid) in greenstone traps, in basalts, in trachytes, in dolorites and other volcanic rocks.

4th. The occurrence of diamond and gaseous hydrocarbons in volcanic necks and pipes.

5th. The occurrence of gaseous and liquid petroleum in the volcanic emanations of to-day.

6th. The occurrence of petroleum in freshly ejected scoriae from the volcano Vesuvius.

In confirmation of the above a specially interesting proof of the occurrence of petroleum in crystalline rocks, in volcanic or igneous rocks or in close connection with these, and in metaliferous veins, may be cited:—

The occurrence of oil around volcanic necks, Mexico:—

7. Journ. Can Min. Inst. Vol. VI, 1903, pp. 73—128.

In the State of Tamaulipas, Mexico, in the Gulf-Coast lands, the oil deposits are found around vertical borings, chimneys or pipes drilled upward through undisturbed and almost horizontal shales by volcanic action during the Pliocene and perhaps Post-Pliocene times and forming small isolated cones ranging from a few feet to four or five hundred feet in height. These cones of volcanic origin spread over the coastal peneplain and consist either of solid basaltic lava or of basaltic tufa. At the base of these cones, or in their neighborhood, are to be found the greater number and more important seepages of oil. The Mexican Petroleum Company, at Ebano, near Tampico, have obtained their more productive wells at the base of the tufaceous cones, such as the Cerro de la Pez, where from but very few wells around this hill they have secured a daily output of 6,000 barrels. In the more highly productive wells of this company the heavy oil, abundantly charged with gas, carries a sandy material consisting of small sharp pieces of shale, fine lapilli, and volcanic sand. The conditions above described as to the occurrence of oil prevail in an extensive zone of the Gulf-Coast lands and extend further south in Mexico to the northern half of the State of Vera-Cruz.

In the sedimentary strata of all ages some of the sediments, principally sandstones, conglomerates, limestones and sandy shales are occasionally quite porous rocks, and therefore may and do form catch basins, tanks or reservoirs for gaseous or liquid petroleums forcing their way under strong pressure through the fractures, fissures, seams and joints of the strata. These reservoirs when thus filled constitute the important petroleum deposits, the commercial oil—and natural gas-fields. They are found indiscriminately in hundreds and hundreds of horizons in the strata of all ages, from the oldest paleozoic to the alluvial gravels and sands of the Quaternary. The natural gas or gaseous petroleum in these reservoirs is always found to have a heavy pressure, sometimes as high as 1,500 pounds to the square inch and in this connection the most important fact to be noted is that this pressure increases in each particular field with the depth of the porous reservoir or "sand" containing the petroleums, indicating that its source is from below.

Far from forming, like the coals, uniform beds, spreading out uninterruptedly in every direction over wide regions, the petroleum reservoirs on the contrary are always found to form comparatively small, local, accidental and irregular pockets, pools or fields. In these pools or fields themselves extreme irregularity is often the characteristic of the reservoirs; patches and strips of barren and productive territory being intermixed in most intricate manners, leading often to productive wells being surrounded by dry holes, and vice versa. In many of these fields the oil and gas are obtained in a number of different sands or reservoirs, some of which are hundreds and thousands of feet lower than the upper one and again in that respect in some of the fields there is great irregularity as to what depth the pro-

ducing reservoir will be found; in neighboring wells the oil or gas may be tapped at entirely different depths. To any keen observer the above features at once demonstrate absolutely that the petroleums in all of their reservoirs are wanderers, not in their original home, and that all their deposits are deposits of secondary impregnation.

Origin.

The opposite chemical nature of the members of the two series of natural carbon-compounds, namely, oxidized complex carbon-compounds for the coals and a mixture of reducing hydrocarbons for the petroleums, gives us the first hint of the surface or external origin of the coals and of the internal origin of the petroleums. Beneath the earth's surface, as is well known, there is a deficit of oxygen, and hence we find none in the natural hydrocarbons from the interior, except in the solid varieties which are the oxygenated and sulphureted residues of the other petroleums in places where they came near enough to the surface. The coals on the contrary obtained their oxygen from the atmosphere at first in their original state of vegetation, and have retained part of it during the carbonizing process to which they have been subjected.

Coal Series.—The origin of the members of the coal series from the natural decomposition of vegetable matter, either in place or drifted, is abundantly proven, and is now generally acknowledged and admitted among geologists.

Petroleum Series.—It is, however, very different in the case of the petroleums, the origin of which is still admitted by many, as a matter of fact requiring no demonstration, to be due to some unseen and unexplained decomposition of organic matter. Other geologists have discussed the subject at length and have tried to prove the organic origin of the petroleums, but not one has ever been able to point out to a single case where a petroleum production process coeval with the kingdoms of life could be witnessed in nature to-day. Some other geologists are discouraged and proclaim the origin of petroleums as a profound mystery not yet solved by science.

As I have long contended, I, for one, cannot understand how it is that the solfataric volcanic origin of the petroleums should be considered as any more doubtful and less proven than is the organic origin of the coals. It seems to me that the geological facts proving the one are just as clearly established scientifically to-day as are the facts proving the other. They are simple facts, the A. B. C., so to say, of geology, and yet strange to say they are every day ignored and set aside.

The origin of the petroleums is not organic; that it is volcanic is absolutely proven by:—

1st. The fact that volcanic emanations of hydrocarbons are the only natural geological process of petroleum production of

to-day, abundantly verified and witnessed in actual operation in volcanic eruptions and phenomena all over the world.

2nd. By the presence of petroleum in volcanic rocks, igneous rocks, metalliferous veins and meteorites.

3rd. By the rock pressure of the natural gas in the petroleum deposits. This pressure always increases with depth in each field; it has been well proven that it is not an artesian water pressure from above, and it cannot be explained in any other way than as a remnant or spark of the volcanic energy forcing the petroleum through the crystalline rocks and all the sedimentary strata from below.

4th. By the products associated with the petroleum in their reservoirs, principally salt, sulphur, hydrogen sulphide, gypsum, calcite, dolomite and silica, which are also the products associated with hydrocarbons in the volcanic emanations of to-day. This association is the unmistakable solfataric volcanic seal which I pointed out before (8).

5th. By the hot oils, gases and waters in some of the more recently formed petroleum fields.

6th. By the fact that the petroleum deposits are located along the faulted and fissured zones of the crust of the earth, parallel to the great tectonic, orogenic and volcanic dislocations and in "petroliferous provinces" analogous to the metallogenetic provinces of DeLaunay, Lindgren, Spurr and other writers. These petroleum deposits could not be inseparably and intimately connected with the tectonic structure of each particular region unless their source was as deep seated as the forces which have caused these profound dislocations of the crust.

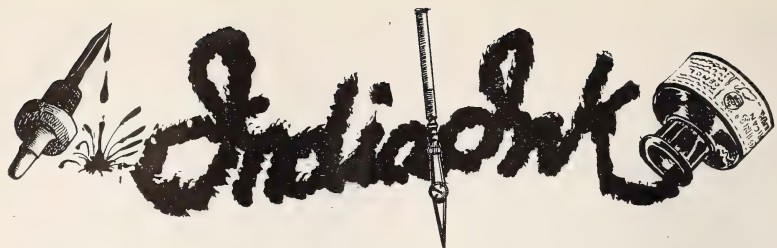
7th. By the fact that petroleum is never indigenous to the strata in which they are found, and are clearly secondary products impregnating porous rocks of all ages. In all fields there is always a lower horizon in which the petroleum is found, until finally the crystalline rocks are reached, and they are even found in these. This adventitious nature of the petroleum deposits is further illustrated by the deposits of solid petroleum which cut through all rocks in veins exactly similar to mineral veins.

8th. By the fact that petroleum is found in such abundance in certain small localities, while neighboring localities are found entirely barren; this forces one to the conclusion that they must originate from the volcanic tank below which is the only one adequate to furnish these enormous quantities to narrow long belts or to small isolated spots, such for instance as the one hundred acres of the Spindletop Mound, near Beaumont, Texas, which has already produced about 38 million barrels of oil; such as the one billion of barrels produced from a small area in the famous oil-field of the volcanic peninsula of Apcheron, near Bakou, Russia; and such as the millions of barrels produced in many other fields from very narrow long belts while areas

many scores of times larger next to the producing strips are barren; this cannot be held to be an accumulation in the producing fields from vast surrounding areas of sediments, as if this was supposed one could not explain why the petroleum did not escape to the surface instead of travelling so far laterally.

9th. By the fact that the sedimentary strata of the oil-fields are so highly impervious that the volcanic fracturing and fissuring and the volcanic force of the natural gas alone can explain how so many small porous receptacles at different horizons between these impervious strata, have been filled with petroleum, salt and sulphur waters, and how these small detached petroleum reservoirs are found to-day under a gas pressure which increases with depth in each district but is nevertheless a stored energy which will dissipate gradually in the utilization of the oil-field, the volcanic energy which brought it there at one time being now dead and inactive.

Before concluding permit me to insist on the fact that the recognition of the solfataric volcanic origin of the petroleum not only removes every difficulty in the way of a full comprehension of all the chemical and geological facts established to-day with regard to the nature and mode of occurrence of these products, but it fully harmonizes also with the physical laws governing the circulation of gases and liquids through great thicknesses of very impervious strata before being able to reach to and accumulate in a few small separated receptacles in the midst of these. The volcanic origin of the petroleum forms, therefore, a complete chain of evidence, with none of the links weak or missing. The very reverse is the case, as I have shown above, when one attempts to explain the origin of the petroleum by means of organic sources;—in doing so, well known chemical and geological facts are set aside and ignored and physical laws are distorted and abused. The geologists who still hold these views should seriously reflect on this, and I am confident that if they do they will soon abandon and relegate to the past the old unsupported notion of the derivation of petroleum from organisms and that they will come to the conclusion that this idea is now unworthy of the progress made by the geological science of to-day.



A RETROSPECTION.

BY C. M. CANNIFF.

(Illustrations by W. Van R. Reynolds).

Mr. E. C. Easy, C. E., inserts as foreword to his monograph this well-known quotation from *Pickwick Papers*: "Tears never yet wound up a clock, or worked a steam ingen." Then, and thus, he goes on:

In amiable response—for I'm nothing if not of the anything-for-an-Easy-life sort of chap—in a true, free-grant response to a request of the Secretary of the Association for a paper, "even," he pleaded, "even if it be only about India Ink," I sat down with my "comfiest" pipe and thought long and earnestly. Two subjects readily suggested themselves and were hard to down: "The Reign of the Parallel Ruler," and "The Yonge Street Bridge Disaster, with Special Reference to the 'Long Lost Chord,'" but as I realized that the Secretary best knew the Association's requirements—had given me, as it were, an India inkling of the same—I duly conveyed to him a few random reminiscences upon the ink our fathers wore out. Surely, my masters, it is eligible for an elegy.

In a familiar, eat-out-of-your-hand manner, conversational-like, so as to make due clarity of a subject somewhat obscure, I proceeded as follows:—

You will bear in mind the India ink I refer to—the sort, don't you know, in vogue before the genesis of *coli communi*, before we had the autocrat of the autocart—in the days historic, when we took a week with a half-hour plan. So I began blithely.

Not having what you might call a fair start, just here I swung off on a three-throw switch or something, and hazarded a remark or two about these plans of yore. Happen with the best of writers, what? One whole day usually went to make a survey for a border that would close, and a couple more for a title.

Nowadays, we make the most commodious border as single-minded and undemonstrative as four knitting needles laid one to the next rectangularly, with never a frothy bow-knot or sign of indecision about the corners; but the old idea was to rhapsodize about and fret them in a whirling eddy of random fuss and fancy. And those prideful, richly dowered titles, bedecked as any strutting peacock, with their reverse curves, and fantastic, festive, fes-

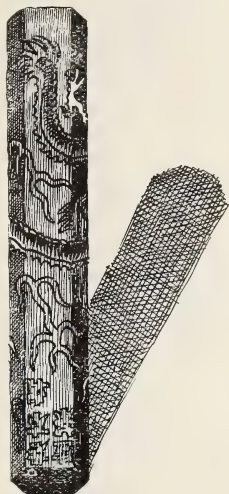
toons; curlicues, cavorting roundabout as lightly as Raphael's pictured children; they were very eye-feasts, dithyrambs in sinuous black and white. In their French curve elaboration, for pure flamboyant beauty they ran a close second to a moving picture of a choicely romantic water-fall, or the trail of a champion skater on keen ice doing what is technically called "the grapevine, with variations." The delineator had to draw the line somewhere, of course, but managed to get it pretty promiscuous and bountiful. And if the mantling title did not vaingloriously dominate the plan, the "North Point" did. It was always kicking up high jinks, always posing. In brief, your North Point, instead of being the outspoken, lean and grim thing of to-day, was nothing short of a ballad, your border was a roundelay and your title made a noise like a cross between a grand opera, a warwhoop, and an Aurora Borealis.

But to take to the main line again. The archaic India ink came in long sticks, sort of aristocratic electric light carbons; scale of hardness, 10.99; as to transverse cross-section generally circular, oftentimes square, not infrequently rectangular; or, it might be, glorying in octagonal ornamentality. The vendor handed it over to you smooth, lustrous, embellished with curious cuneiform characters in shiniest gold, or else something horrific in zoological still-life. It was redolent of camphor or vanilla or some other scent of Araby—perhaps elsewhere—also, if you recall, seemed every whit good enough to eat. It yanked one back to the words of Macaulay when he mentions inhaling—no, not the abhorrently vile cigarette, but—

"the balmy smells of nard and cassia which the musky
"wings of the zephyr scatter through the cedared
"alleys of the Hesperides."

You paid good money for it and took it home and injected a modicum of it into your pen.

But the preliminary manipulation. By the welkin and all its planets! The game was "Everyone his own blacksmith." 'Twas fraught with woe exceeding and tribulation. No, you did not go at it with an Indian file — it was a case of circular abrasion by the wet process, for like some mining stocks it was soluble in water. Pampered laborers in the technical vineyard as you are—vain voluptuaries of to-day, satiated sybarites! all you know is how to embathe your pen in some kind of hand-me-down, buy-no-other solution, warranted by the manufacturers of even flow—the which accompanied by its goose-quill stopper, and wrapped in its dainty and gratuitous serviette, its dip cork and clean rag. When you go a-lettering your nerves are steady and



your hand as light as the angel shapes that bless an infant's dream. You're a spoilt lot; you've been spared the stick and brought up on the bottle. To me is it given to comprehend why Keats wrote,

"O aching time! O moments big as years!"

I understand; he wrote with the wrought ink of the dark ages. your hand is light. You're a spoilt lot; you've been spared the stick and brought up on the bottle. To me it is given to comprehend why Keats wrote,

But I fail to fathom why they called it India ink; it came from China. I think it must have been the original Chinese puzzle we hear about. Probably the Li Hi's were ashamed of their Chink ink. Come to ponder it over, Alphonso holds no impregnable patent on the aesthetic yet companionable, even diverting onion labelled "Spanish." These generic terms, like proper names, are often difficult to account for. Not to be egotistical, they call me "Easy," for instance—"which," as a deceased scientific writer of some note has said, "which is absurd."

You call to mind, don't you, you of the older school (as I said before), ere wireless telegraphy—in the days when engineers recked little and cared less about reinforced concrete, and did not give a hoot whether their neutral axis was situate, lying or being in the floor plate above, in the beam beneath, or in the footing under the earth—you call to mind, don't you, the "demonition grind" in those flat saucers? Bethink yourself of the crick you used to get in the neck if you had a tracing to make in a hurry, and arrived at the office late, but found your nigrescent fluidity evaporated to a black current jelly consistency, and when (stercoraceous oxgall and slimy soap unavailing) it was up to you to sail in, seize that little imp of darkness and slush round for a fresh brew?

It reminded you of the sign that a friend of ours who was away behind in his work put on his door: "Surveys and Plans made while you wait." Funny, wasn't it, how every table you tried was shaky, and you were fated to get your incubator (shall I call it) on a high spot, provocative of a grumbling noise like a loose dumb-bell in a barrel-dragging anchor in a down-grade tunnel. Has your memory lapsed concerning that "roughly" spot that you tried—mistakenly—to strike because it seemed like something doing. You learned to do two things at once, grind ink and grind teeth.

You would start off, patiently, pensively, with nice clean water in a scrupulously cleansed side-dish, and rub and rub (round, round and rub), sometimes whistling below your breath like the grooms do when they wield the curry comb—then grunt softly past the dirty clean water, or ten cent sugar period (round, round and rub), through the creole, or fine cut, or mud-pie stage (round, round and rub), past the sad-colored black-strap semaphore (rub and rub and rub), until at length after twenty min-

utes or so your product looked as Ethiopic as a burnt cork in the inside of a blind cow wallowing in a pile of soot during a heavy thunderstorm.

Pshaw! a trial trip with a drawing pen produced only a dim grey line. No, more yet, keep at it! You were in a bad case. You wondered if stove polish—anything else—would work. Away you went till your head swam. Talk about radius of gyration, talk about the mulberry bush (round, round, round—rub, rub, rub). You had to hang on like a pup to a root. With blinkers goggled and brain reeling, you considered the chipmunk in his treadmill, going and going and arriving nowhere. "Grinding poverty" (pish, pish—tush, tush)—here was a very wealth of it.

The very devil was in that ebon shaft of hard-boiled ink of the middle ages, with its undecipherable cabalistic legend in gilt. It was bewitched, it was fey.

I can even yet see the specks and motes and hairs and other aerial debris that gravitated to the saucer. It took to whiskers. This old-time blacklead was as the fabled course of true love—it ne'er did run smooth and probably not of it written, "dark as midnight was the flow."

Then the oxgall pot would be seized—that epitome, that concentrated essence of odorous abomination—and you would surcharge your refractory dusky dye with an adult's dose of the contaminated run-easy.

You said in your heart. "All Gaul is divided into three parts, each smellier than the rest."

Next, the rubbing dry to a polish of your wet stick; if no rag were handy, the office towel suffered, or maybe the furring of the lowest portion of your pant leg. This was to prevent your stick cracking, also granulation of its nether latitudes. If cracks came, the only remedy lay in a surgical operation ending in a bandage of glued tracing cloth. If granulation set in, the little hard pellets had to be disintegrated with a knife.

Is it brought back to your memory how when you eventually achieved a choice deep vessel of jet-hued fluidity, you would attempt to prevent evaporation by wetting the rim and carefully pressing the cover tight? Many's the time and oft when you removed the lid you absent-mindedly laid it on your well-stretched drawing, projecting thereby a tolerably accurate embossed circle like unto the ground plan of a standpipe or a silo. When your toil was over, your cuffs were dishclouts, your vest was smeared, collar spotted, nose smudged, and altogether you were a realistic echo of somebody in a bad temper, and about as useful for a time in your chosen profession as an aneroid with appendicitis.



How a pig-tailed Oriental mixes his ink and keeps clean, search me! Small wonder they run to laundries—and opium. Pardon me for a temporary surrender to the seething within of the divine afflatus, but—

There was an idiosyncrasy about India ink,
'Twas best to be ground in an odious sink.

However, I want merely to explain how our office in those days got “woke up” and exchanged the tyranny of the old line India ink stick for the solace of the bottle, how it adopted the “Higher Inkism.” It happened, of course, in the big draughting room. How well I remember it. First me; I was excessively busy, having got my level book all messed up through want of a little foresight; then, there was Mr. Brown, engaged on a colored sketch that no artist could paint; lastly, the chief—but more of these later.

The usual expensive Brussels carpet covered the floor; the familiar mottos and such like adorned the walls. Everything bound in Russia leather, the library made a brave showing with its technical reference books—“The Complete Angler,” “The Hundred Best Receipts for Fly Oil,” and the rest. Over the door was “God Bless our Home when Daddy’s in the Bush.”



The chief was Irish, a Dublin C. E., as I said, married, nine children; used to advise his pupils not to marry if they wanted to be successful; if they did, they became so much matched lumber. He ate Higher Mathematics like a sword swallower. I remember when I first came, and tried to be sociable. It was an off day, and he was calmly discussing his lunch, poring over a chapter of Quaternions, and licking his lips — over which, I know not. I ventured a suggestion that his page of equations looked like blank verse with the colic.

“Young man,” responded the chief, gravely, “Quaternions are the poethry av mathematics; for universalithy, that attrIBUTE of your Homer, and Dante and Shakespeare—is the very essential oil of Quaternions.” I succumbed.

In common with others of the old school, upon hearing first of it, the chief was quick to damn hand-me-down ink as the “devil’s frippery and seduction.”

“That botthled matharial can’t bey anny good,” he declared; “I av used rubbed ink frish-made daily for forthy-five year.”

Here the assistant looked up from his labor of emptying half a barre lof riotous blazonry atop of a title, and he chipped

in and still further desecrated the accustomed environment of grace, mercy and peace. My particular aversion — was this assistant, super-supercilious, so self-sufficient. I used to wonder if there was not something I could put in his coffee and cure him secretly at home. He was tall and had an ingrowing voice cast from Cockney patterns. A pet affection was a blue-flowered waistcoat with whole battalions of large thirty-two candle-power buttons. He wore a glass in his eye, and more rings on his fingers than Saturn—also spats. I've known him cross-section a doleful dump of street cleanings in tan shoes and lavender spats. He revelled in Troy weight machinery about his necktie. To hear him talk you would have thought him possessed of all the winnowed and garnered engineering wisdom of the ages, whereas in truth he had only built a couple of pigeon-hole dams and dabbled in a few other technical trivialities.

Invariably Mr. Brown cast more disparagement upon me and my brand of inkcraft than the chief himself. If, perchance, I was being criticized, he would stand and grin through that ridiculous monocle of his, with an intolerable expression of amused interest. Now, having decided that it was nobler in a man to carry a transit over his shoulder than a shovel, and with the Second Year A. S. germ in my system, can you doubt that, having accidentally come to know and bless the name of Stiggin's Ink, the jendulum of my ambition to grind the heathen article had about reached the limit of its arc?

"But you have never used Stiggin's Ink," I expostulated, pursuing an argument that became almost a scene.

"Stiggin's! Oh, I say!" echoed the assistant in his accustomed tone of mockery, his aristocratic nose tip-tilted in scorn, "a vain thing fondly invented. Strikes me, the trouble with you young 'uns at the School is that you think you know it all. My word! you rub up ink like a half-breed cook brews coffee—it's either too bally thick, or too bally thin, or it's chock full o' grounds. Why, blame me, it's grind my own jolly well decent stuff for a plan. Look at this lettering now, I say, black as your boot—that's the way to have ink, ain't it, chief? That's what you call ink." And he purred along, and me crestfallen, and the chief commending. "No, siree," continued Mr. Brown, "none of that stuff for me. At the Registry Office they siy it jolly well fides out, and then where are their bloomin' records?"



"Yes, that's the kind of thing," after examination, commented the chief; then with some asperity, "Be the powers. Aisy, you

raily ought to pay hade to Mr. Brown. I niver like your ink, someway. Watch how he does it next toime. Rimimber the name of ye, Aisy, and 'Aisy does it' ye know. 'Nothing should be done in haste 'cipt catching fleas'—that's an ould proverb."

Mr. Brown gave an upward shear to one side of his circular optic glazing, it shot downwards, and he guffawed hugely. "Right, right-o, chief," said he, when his paroxysm had moderated to the old familiar smile. I gritted my teeth in silence. Mr. Brown slowly screwed his double sash in place, and resumed his drawing pen with, "Yes, Easy, you've a brisk lot to learn yet," the while a sardonic, facial expression as though some great sorrow had come to him.

Right there I noticed something peculiar in the assistant's movements—caught his eye momentarily—could I be right? With that transient gleam from the obtrusive monocle did there dart a weeny, little isolated arrow of menace? I had either to fight or get licked lying down.

I finished my task and convoyed my fresh saucer of ink over to the chief, who, by the way, was impatiently waiting to complete a sketch which had to catch the noon mail. Whatever happened, the dish slipped through his fingers and landed skew-"g"* on the floor. The language he employed towards

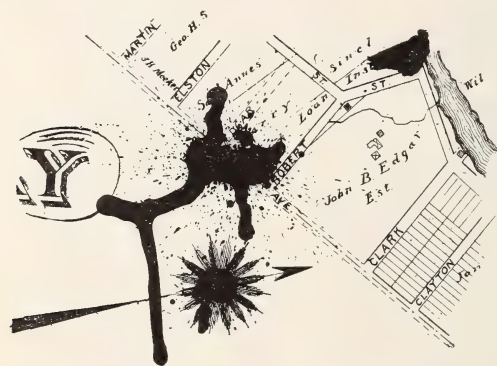
me did not fall exactly as the grateful dew upon the green and tender herb of the field. However, talking of super-heated language, I care not who does the swearing of a country, if I build its dams.

"How in the 49th parallel d'ye think Oi'm to finish this now?" he queried, catching his breath. For a brief space the

silence was that oppressive one could stick thumtacks in it.

Even a worm will turn. "Maybe Mr. Brown'll lend you some of his," insinuated I, with never a smile, valorously challenging fame and glory. "There in that top drawer," I nodded to the assistant, "covered over with your newspaper." The eyeglass took a sudden drop, and so did Brown, Esq.

The chief was in a hurry, and there was nothing for it. I *had* Sir Assistant. He was harried and undone. "Eh, what? Confound it! Go, blime me!" Just like that. "It's a bottle of Stiggin's Ink, that new-fangled stuff, don't yer know, that they presented to me to try—Piper's shop downstairs," thus he owned up, elevating it with a ludicrous over-the-fence-is-this-your-cat expression.



* For value of 'g' see any standard text book.

The chief, straightening his back and face, softly enquired, "The kind that makes those bee-u-thiful black, very black lines?"

"Yes, sir, guess I got hold of an extra good bottle. There's a drop—only a drop—left at the bottom," and he handed it to the chief, looking as foolish as a man caught standing on his own foot. Misfortunes never come singly. Slip, plunk, splash—and the precious bottle took a personally conducted tour around our feet.

"Aisy," spoke the chief, twisting to me with a jerk, and with something of the lambent aurora of a smile pervading the purlieus of his mouth, "Aisy," he commanded, "emigrate down to Piper's shop and buy a pint and a half of Stiggin's Ink. Git anything to irrigate a pen." And he gave a last, long, resigned sigh not unlike a sand pump in deep thought.

"Yes, sir," was my response, already half out of the door, "shall I get the waterproof kind, sir?"

"Shure, to be shure," dreamily responded he, "procure th' amphibious kind. Maybe I'll want to wape whin I use it."

You will be expecting that by now Mr. Assistant was in a state bordering on nervous collapse. Disillusion yourself, please. Just as I was disappearing, he called, accompanied by his faithful eyeglass:

"Yes, and—I say—Easy," came the request, "heah's five and twinty cents to get me a fresh bottle, and look, see that—er!—see that they slit the quill so's a cove can jolly well write with it. Now go—there's a good chappy."

I went. Didn't I just!

From that time the Oriental product that had to be hand-churned was as extinct as the Great Auk, or the Dodo, or the Winged Crocodile, or the Millionaire Engineer, or the Dishonest Contractor.

It was gone, and with it the daily grind. Plans of same may be seen at the office of the Government Engineer. There's a time for everything—beshrew me else—but in this epoch of strenuous Rooseveltism, none for the hand-wrought ink. It is as obsolete as pyramidal duck eggs in a surveyor's office in this year of grace.

Petrified India Ink as an institution was interesting. It is not all uncelebrated and unsung, for a certain minstrel, albeit with broken voice and shivered harp, has it thus—

Conceive him if you can,
A rotary fist young man;
An India-Inkety,
Grind-at-the-sinkety,
Black-to-the-ears young man.



WHAT THE GRADUATES ARE DOING.

This section is conducted with a double object in view—First, to give the graduates professional news of each; secondly, to give the undergraduates an idea of the possible fields of employment open to them in the future.

Geo. H. Power, '01, is installing a sewage system at North Battleford, Sask.

A. L. Ford is government inspecting engineer on the G.T.R. at Prince Rupert.

R. S. Davis, '07, is with the Canadian Westinghouse Co. at their Winnipeg office.

E. M. Wood, '06, has joined the staff of the Hydro-Electric Power Commission..

W. K. Greenwood is resident engineer on Clinton, Ont., waterworks construction.

W. S. Pardoe, '04, has been appointed to the staff of the University of Pennsylvania.

T. H. Hogg, '07, last year demonstrator in Strength of Materials, is with the Ontario Power Co.

W. P. Linton, '06 and L. R. Wilson, '09, are with the Dominion Bridge Co. at Montreal.

F. W. Harrison, '05, is chief mechanical draughtsman of the New York Edison Co., at Brooklyn, N.Y.

F. C. Smallpiece, '08, is assistant manager of the Montreal office of the Canadian General Electric Co.

F. E. Prochnow, '08, is taking up Patent Attorney work with Wilhelm, Parker & Ward, Buffalo, N. Y.

W. V. Taylor, '93, is with the St. Lawrence Stevedoring Co., Quebec for handling N. S. S. & C. Company's coal.

W. G. Hewson, '05, is with the Westinghouse Electric and Machine Co. in the Railway Engineering Department.

J. T. M. Burnside, formerly Chief of Location on the Canton and Hankow Railway, has returned to Canada.

J. G. McMillan, who was with Capt. Bernier for the last two years on the Arctic Expedition has returned to the city.

J. G. Fleck, '04, has forsaken the field of engineering and is a member of the firm of Fleck Bros., Limited, Vancouver.

J. H. Rychman, '06, is with the Chicago, Milwaukee & St. Paul Railway in the Bridge and Building Department at Chicago.

We regret to report the death of Milton Bates, '06. A full obituary will, according to our custom, appear in the final number of this volume.

W. H. Sutherland, '02, is with the Montreal Water & Power Co. in charge of operation of pumping plant—steam and electric—and distribution system.

APPLIED SCIENCE

INCORPORATED WITH

Transactions of the University of Toronto Engineering Society

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE
AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO.

Published monthly during the College year by the University of Toronto Engineering Society

BOARD OF EDITORS

K. A. MACKENZIE, B.A.Sc., '06	Editor-in-Chief
J. C. MURTON, '10	Civil and Arch. Sec.
H. W. FAIRLIE, '10	Mech. and Elec. Sec.
C. G. TITUS, '10	Mining and Chem. Sec.
W. D. BLACK, '09	Ex. Officio U.T.E.S.

Associate Editors

H. W. PRICE, B.A.Sc., '01	Mech. and Elec.
P. GILLESPIE, B.A.Sc.	Civil and Mining
M. C. BOSWELL, M.A., Ph.D., '00	Mining and Chem.
W. TREADGOLD, B.A., '05	Railway

Advertising Committee

H. W. TAIT, '09.	R. FULLER, '11.
E. A. JAMIESON, '10.	J. GALBRAITH, '13.

Treasurer: F. V. MUNRO, '09.

Subscription Rates

Per year, in advance	\$1 00
Single copies	20

Advertising rates on application.

Address all communications:

APPLIED SCIENCE,
Engineering Bldg., University of Toronto,
Toronto, Ont..

Editorial

This number of Applied Science begins the third year of its existence. It is expected that the healthy growth of the past two years will continue, and that its influence for good, both among the graduates

Introduction

'09-10.

and undergraduates will continue to increase. If it succeeds in keeping the alumni more closely in touch with the University and with each other it will have accomplished one of the main objects of its existence.

During the summer blank forms were sent to all graduates asking for a complete record of their experience. It is very necessary that this information should be in the Secretary's office. Some of the questions asked were, in the eyes of some, regarded as rather personal, but the graduate need not answer these unless he so desires. However, the record of experience is very necessary, continually cases are arising when the informa-

tion asked for would be of mutual interest to the graduate and to the faculty. With it perhaps the authorities would not be constrained to go out of the profession when they wanted a superintendent of buildings, or out of the country when they want an expert report on engineering matters. With it we may be able to convince the business men of Canada that we can produce men who can and have handled engineering problems of the greatest magnitude successfully, and the legislature that an engineering college is a most valuable asset to the province.

The question of an employment bureau is a natural result of the information to hand, but is purely second to the general object. During summer we were able to place a great number of graduates—particularly experienced ones—and could have placed a great many more had they been available. We have at present a number of requests for experienced men and would advise all who are contemplating a change to fill in the blue slip and forward to the office.

Employment Bureau

There is a general feeling of pride in the new Thermodynamics and Hydraulic Laboratories, which easily rank among the finest on the continent. Although hardly as complete and as extensive as those of Germany, described by Prof. Angus, in his paper on European Laboratories, yet sufficiently well equipped to give the students a thorough knowledge of the basic principles of mechanical and hydraulic engineering, and at the same time to give ample scope for research work. The question of research work is one that must be taken up and thoroughly discussed in the immediate future. The new laboratories will be fully described and illustrated in a future issue. It is the intention to open the new buildings officially in December. This year's freshmen class enters on the new four-year course. In numbers it is slightly smaller than its predecessor. This is explained neither by the increase in fees nor lengthened term, but by the rise in the standard of matriculation. The incompetents and the unprepared were weeded out more thoroughly and this year's class is among the most promising in the history of the Faculty of Engineering. On the whole, the changes in the curriculum have given general satisfaction. The new course in accounts and business organizations is welcomed, but general regret is expressed that the course in English has again been delayed. If the reasons are financial it is hoped that another year will see this very necessary side of engineering education receive its proper recognition.

New Laboratories

THE ENGINEERING SOCIETY.

This year sees the affairs of the Society in the most healthy state of its existence. The Executive of '08-'09 stepped out leaving a considerable surplus in the treasury.

The incoming Executive, which has shown itself thus far to be a progressive one, was not slow to grasp this opportunity for expansion.

At the first meeting of the Faculty Council the President invaded the sanctum with two propositions and found that august body as usual willing to give full consideration to proposals emanating from the Society.

The first of these proposals was in regard to the rearrangement of the Faculty Library and the Supply Department. This room serves for the combined use of the library, reading room, supply department and office of paid secretary and assistant registrar, and was laid out apparently without regard to economy of space. Plans were submitted showing where all concerned, particularly the Engineering Society would be benefited by a change in the arrangement.

A committee was appointed which after considering the proposition gave the Society power to make the proposed changes. This change results in giving the Society the north side of the room, with a counter 24 feet in length and an opportunity to display the stock. This is a decided improvement over the old L-shaped counter and crowded corner of the original arrangement. A modern two-drawered cash register is much in evidence and a permanent sales clerk is employed and the department kept open at all hours.

We have developed here the ideal system of co-operative purchase and sales. We buy our supplies at lowest rates and sell at our own prices. For several years we have had printed and have sold printed notes of lectures. This year "Applied Statics" notes by T. R. Loudon have been bound and are offered for sale by the Society at cost price. We now meet with a demand from the Students' Book Department, which is properly speaking not co-operative, to hand over the sale of such books to that department. Needless to say we feel it an injustice to be asked to hand over a field which we have exploited, in this way. The Supply Department has become of prime importance in enabling us to carry out the undertakings of the Society.

The second proposal with which the Council was approached was to hold an exhibition or conversazione in connection with the official opening of the Thermodynamics and Hydraulic Laboratories.

The definite shape which this scheme assumed was that the four engineering buildings should be linked together. A pamphlet or book descriptive of and illustrating the features of the Faculty of Engineering should be published for distribution, and several thousand invitations issued for the first night of the function. All the buildings should be illuminated and decorated

and everything in working order. The official opening by the Governors should take place in the new buildings and then all machinery set in motion through the buildings and experiments be conducted and the conversazione would be in full swing, with addresses being delivered, in various lecture rooms, of popular interest. Orchestras should be in attendance and refreshments served in the large draughting room.

The next afternoon the conversazione would be continued, and the buildings thrown wide open to the public. The final function would be our annual dinner, with an opportunity before the dinner for our guests to be conducted through the buildings.

The object is to bring the Engineering Faculty more in the public eye, to reach everybody from the cabinet minister to the apprentice boy, to show the public how their money is being spent for the industrial advancement of our country, and to show to the manufacturer, contractor, etc., how the graduate is being equipped to become a useful employee, and promoter of industrial enterprises.

It is needless to add that the Council at once grasped the full significance of the advantages to accrue to the successful carrying out of this scheme and have done everything possible to further the proposal, with Prof. Angus as chairman of the committee appointed jointly by the Council and the Society. The matter is now somewhat in abeyance pending a grant by the University Governors, but will be pushed with the greatest enthusiasm as soon as notification advising us of such a grant is received. The Engineering Society looks to the graduates for their active co-operation in making this function the great success it promises to become.

In view of the amount of work entailed by the carrying out of this proposal and for other reasons understood, but not mentioned, the Council refuses to give the official seal to the annual excursion. It is the wish of the Faculty that Sectional excursions be undertaken as offering greater educational value to the student. This policy has been approved by the Society Executive.

The first general meeting of the Society, October 6th, was largely attended, when an able and interesting address was delivered by W. J. Francis, C. E., on "The Relation of Technical Education, Personality and Character in the Work of the Engineer."

The three sections of the Society held their regular meetings on October 20th. Eugene Coste, M.E., addressed the Mining and Chemical Section on "The Origin of Oil"; C. R. Gully, B.A.Sc., the Electrical and Mechanical Section on "Transformer Testing"; W. G. Swan the Civil Section, on "Railroad Location."

We have a number of requests for experienced men, particularly in the electrical and mechanical departments. If you contemplate making a change communicate with the editor.

